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(54) LOAD HANDLING VEHICLE

(71) We, LINER CONCRETE MACHINERY COMPANY LIMITED, a British Company, of Park Road Works, Park Road, Gateshead 8, Tyne and Wear, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention concerns improvements in and relating to load handling vehicles in which manipulation of the load by the driver can place the vehicle in an unstable position. With known vehicles it is possible to tip the vehicle over by lifting loads which make the vehicle unstable or by altering the position of the load by various means such as jacks, ropes, extending booms etc. thus endangering the stability of the vehicle. Many safety devices have been put forward to give the driver audible warning of instability and/or make the vehicle safe and it is an object of the present invention to provide a simple yet safe method of warning the driver when his vehicle is becoming unstable.

Known forklift vehicles suffer some disadvantages when they are required to load, for example, container vehicles, aircraft fuselages or the like where the loading deck is at a height above the travelling surface of the forklift vehicle since the raised forks of conventional forklift vehicles cannot safely be extended and retracted horizontally forwards and backwards to fill the front portion of such container vehicles, aircraft fuselages or the like because, by extending the forks, the vehicle may become unstable.

Patent No. 1186616 which relates to improvements in sprung axles for load handling vehicles. A sprung axle assembly is described for use in a load handling vehicle which includes an axle element adapted to carry a pair of ground engaging wheels at its opposite ends respectively, means for mounting the axle element on the vehicle chassis for pivotal movement relative to the vehicle chassis about a first axis extending transversely of the vehicle, said axis being spaced from the axis of the said axle element, a pivot pin about which said axle element can pivot and which is disposed longitudinally of the vehicle in use, the pivot pin moving with the axle element when the element moves about said first axis and being movable longitudinally with respect to the axle element, the end of said pivot pin remote from said first axis being engaged in use with an inclined surface fixed with respect to the vehicle chassis, and the assembly further including a spring acting on the pivot pin to move the pivot pin axially in such a direction that, in use, cooperation of the pivot pin with said inclined surface opposes the weight of the vehicle which weight acts to move the chassis and the axle assembly towards one another about the said first axis. In an alternative embodiment of the device therein described, provision is made for the replacement of a member of the first embodiment (described above) with an electrical/hydraulic load indicating instrument. The horizontal movement of a spring for the measurement of a load will give neither the accuracy nor the sensitivity which is achieved by using the direct downward pressure of the superstructure and the load to give an indication of the turning moment.

An object of the present invention is to provide a load handling vehicle which is capable of safely raising a load and placing it at a distance from the vehicle without movement of the vehicle chassis relative to the ground, whilst minimizing liability of the vehicle to tip over.

According to the present invention there is provided a load carrying vehicle comprising a chassis and a superstructure with a lifting member capable of raising a load and placing it at a distance from the vehicle, characterised by the provision of a strain gauge mechanism comprising a pin, positioned

between the chassis and one of the axles of the vehicle in such a position that when in use a cantilevered strain is put on the pin so as to operate at least one strain gauge, as herein defined, operatively associated therewith by an amount proportional to the direct downward pressure applied to the said axle by the weight of the superstructure and the load so as to detect changes in the turning moment applied to the said axle along the longitudinal axis of the vehicle by the weight of the superstructure and the load and mechanism operable by the strain gauge mechanism to give warning when the turning moment about the said axle is such as to render the vehicle unstable.

In a preferred embodiment the invention provides a load handling vehicle comprising a chassis and a superstructure with a lifting member capable of raising a load and placing it at a distance from the vehicle, characterised by the provision of a strain gauge mechanism connected between the chassis and a rear axle of the vehicle to detect changes in the turning moment applied to the said axle by the weight of the superstructure and the load, the strain gauge mechanism comprising a pin with strain gauges, as herein defined, mounted thereon, the pin being mounted in the chassis and a bearing for the pin being provided on a bearing carrying member mounted on the rear axle of the vehicle so that when in use a cantilevered strain is put on the pin, and further characterised in that the strain gauge mechanism is electrically connected to audible and/or visual alarm means so that electrical signals from the strain gauge give warning when the turning moment about the said rear axle is such as to render the vehicle unstable.

The strain gauge mechanism is therefore preferably mounted on or near an axle that tends to lift off the ground should the vehicle become unstable. This axle would be the rear axle should the lifting member e.g. a boom be mounted at the rear end of the chassis. A vehicle with a rigid front axle and with a boom mounted at the rear end of the chassis will tend to overturn about the rigid front axle should the vehicle become unstable. In such a case, the strain gauge mechanism will preferably be mounted between the chassis and the rear axle at a central point about which the chassis pivots, an intermediary bearing carrying member being provided for the purpose of stability and riding over rough ground.

In one type of load carrying vehicle a boom is extended and retracted hydraulically using chains or wire ropes to interlock sections of the boom, as an alternative or additionally the boom being pneumatically extended or a system of wire ropes and chains being used to extend and retract the boom. A jack for raising and lowering the boom is preferably hydraulic but may be mechanically operated.

In such a vehicle the strain gauge is responsive to the loading of the boom and is preferably arranged positively to prevent further movement of the boom and/or extension thereof when the vehicle is becoming unstable whereby a predetermined maximum turning moment of the boom about the front axle may not be exceeded. The maximum permissible moment is calculated with reference to that which would be required for overturning the vehicle. The strain gauge mechanism preferably closes hydraulic control valves thus preventing any further travel of the boom extension and/or movement of the boom which would create a situation in which the vehicle would become increasingly unstable. It is also preferred that an audible alarm should be given when the vehicle is approaching an unstable condition. If required it is also possible to have a visual display in the driver's cab.

It is also preferred that there be a delay incorporated in the safety system so that momentary instability is not brought to the driver's attention e.g. when the vehicle goes over rough ground and the weight is taken off the back axle due to a sudden bump.

The invention is particularly, though not exclusively, intended for use on vehicles with a telescopic boom, such a vehicle might have a forklift carriage, crane hook, or loading bucket at the end of its telescopic boom. The strain gauge mechanism is preferably mounted in such a way as to give maximum protection to the gauges themselves and the wires leading therefrom.

This invention will now be described further by way of example with reference to the accompanying drawings in which:

Figure 1 shows the side elevation of a load handling vehicle according to the invention having a boom pivotally mounted on a supporting rear member;

Figure 2 shows end elevation of the vehicle of Figure 1;

Figure 3 shows a side elevation of the same machine with boom extended; and

Figure 4 is a plan view of the rear axle showing the way in which the strain gauge is mounted;

Figure 5 shows the circuit for the strain gauge;

Figure 6 shows the hydraulic circuit for raising and lowering the boom.

Referring to the drawings the load handling vehicle comprises a chassis 1 with an engine 2 mounted thereon, a gearbox 3 and four wheels 4. The four wheels are driven by the engine 2 and both front and rear pairs of wheels may be steered either in sympathy or with one pair in opposition to the other pair so that a very tight turning circle may be obtained or the vehicle may perform crabbing movements.

In Figures 1, 2 and 3 the driver/operator is protected by an all-round view cab 5 and operates the vehicle by means of a steering wheel and levers 6. The cab is formed from high grade steel and has toughened glass windows for driver/operator safety. The cab is positioned at the side of the chassis whereby the driver/operator may have a clear view of a load-engaging device mounted on a lifting member which comprises a boom, for all positions of the boom.

The boom 13 is telescopic and a first boom section member 10 is hinged to a boom support member 14 at the rear of the vehicle and is elevated by a jack, comprising elevation control rams 15, the jack operating about hinge points 16. The boom 13 is extended by a boom extension ram 17, which forces a second boom section member 18 of the boom 13 to extend with respect to the first boom section member 10. A third boom section member 19 is forced to extend with respect to the second boom section member 18 by a chain and pulley system between the second and third sections. By this means the boom may be extended to give the vehicle the desired height or reach. The boom is retracted in the reverse manner. A forklift member 8 with forks 7 is suitably connected to the boom section member 19 e.g. by pivotal connection 9 to a bracket 12. The chassis 1, in the region of its rear axle, carries a pin 28 on which strain gauges 27 are located with terminals leading through the pin. Such an embodiment is shown in Figure 4, only the rear pair of wheels being depicted. A bearing 30 for the pin 28 is carried by a bearing carrying member 31 which is mounted on a rear axle 29 of the vehicle. The rear axle 29, pivots on the bearing 30 and allows the vehicle to travel over uneven ground thus keeping the two wheels in contact with the ground. The load at the rear of the machine is carried therefore from the chassis 1 and the pin 28 attached to the chassis, through the bearing 30, the member 31 and rear axle 29 and thus to the wheels 4.

Any load put on the bearing carrying member 31 when the forks 7 of the lift member 8 on the boom are loaded is transmitted to the pin at location 32, thus putting a cantilevered strain on the pin 28. This has the effect of stretching or straining the gauges 27. Thus if the boom is extended whilst the forks are carrying the load or if the load is increased with the boom extended, the turning moment about the front axle, will increase and the strain on the back axle and thus on the strain gauges will be reduced. As the strain on the strain gauges is decreased so the electrical resistance is increased and the signal from them decreases. The signal from the strain gauges 27 is taken to an amplifier 40, shown in Figure 5 which amplifies the signal and then through a time constant device 41 which holds the signal for a set time before allowing it to pass to two level indicators 42, 43, which analyse the signals from the strain gauges and monitor their amplitude. Should the signals decrease to a level, predetermined as the level caused by a turning moment just under that necessary to overturn the vehicle and enough to make the vehicle unstable then the signal is passed through the indicator 42 to a buzzer 44. This warns the driver that the vehicle is becoming unstable. If the signal continues to decrease due to the load being taken off the strain gauges owing to a further extension of the boom and/or overloading of the vehicle then the second level indicator 43 comes into operation and in turn passes the signal to a relay 45, which in its turn activates the respective solenoid hydraulic control valves 33, 34 which shut off the hydraulic control valves for the boom, thus, preventing the driver from overturning the vehicle. In order to bring the vehicle back to a safe condition the driver must reverse the action of the boom thereby increasing the load on the rear axle and the strain gauges 27. The amplitude of the signal will then rise on both level indicators 42, 43 thus releasing the hydraulic locks effected by the solenoid valves 33, 34 and shutting off the warning buzzer 44.

Figure 6 shows the hydraulic circuitry of the elevation control rams 15 including a ripple eliminator 36 and pressure gauge 37. During normal operation of the machine a pump 39, mounted on the engine 2, delivers oil to a control valve 6 which delivers oil alternatively to both sides of the elevation control rams 15 used for raising the boom. When the boom is being raised the oil passes through a pressure compensated regulator 35, which measures out the correct amount of oil needed for raising the boom and for operating a forklift ram 26 attached thereto shown in Figure 1. When the boom is being lowered the oil is sent back to the tank through a non-return valve 38. Coupled into the hydraulic

circuit between the pressure compensated flow regulator 35 and the elevation control rams 15 is the ripple eliminator 36, which gives a pressure reading on a gauge 37 mounted above it. Similarly, as the load on the forks 7 on the member 8 attached to the forklift ram 26 at the end of the boom is increased or decreased, so will the oil pressure in a return line from the elevation control rams also increase or decrease.

As well as providing visual aid to the operator of the vehicle, the pressure gauge can be set to give an audible warning should the pressure in the elevation control rams exceed a certain predetermined amount. Alternatively coupled to the warning buzzer can be an electrical relay which will render the rams 15 stationery by shutting off the hydraulic control valves 33, 34 thus providing an added safety feature.

In this specification the term strain gauge means a gauge the electrical resistance of which changes proportional to changes in the strain applied to the gauge.

WHAT WE CLAIM IS:—

1. A load carrying vehicle comprising a chassis and a superstructure with a lifting member capable of raising a load and placing it at a distance from the vehicle, characterised by the provision of a strain gauge mechanism comprising a pin, positioned between the chassis and one of the axles of the vehicle in such a position that when in use a cantilevered strain is put on the pin so as to operate at least one strain gauge, as herein before defined, operatively associated therewith by an amount proportional to the direct downward pressure applied to the said axle by the weight of the superstructure and the load so as to detect changes in the turning moment applied to the said axle along the longitudinal axis of the vehicle by the weight of the superstructure and the load and mechanism operable by the strain gauge mechanism to give warning when the turning moment about the said axle is such as to render the vehicle unstable.

2. A vehicle according to claim 1 wherein the strain gauge mechanism is mounted on the pin adjacent to a rear axle of the vehicle which would tend to lift off the ground should the vehicle become unstable.

3. A vehicle according to claim 2 wherein the rear axle of the vehicle is held in a central location and is pivotable about this location to negotiate rough ground.

4. A vehicle according to any of the preceding claims wherein the lifting member includes a boom formed in sections which are extendable and retractable.

5. A vehicle according to claim 4 wherein an hydraulic piston and cylinder assembly is provided for raising and lowering the boom.

6. A vehicle according to any of the preceding claims wherein the mechanism comprises electrical circuitry including means to monitor signals from the strain gauge mechanism and means to prevent further movement and/or extension of the lifting member when the value of the signals from the strain gauge mechanism reaches a value indicating that the vehicle is about to overturn.

7. A vehicle according to claim 6 wherein the signals from the strain gauge mechanism are arranged to close hydraulic control valves to prevent further movement and/or extension of the lifting member when the value of the signals from the strain gauge mechanism reaches the said value.

8. A load carrying vehicle comprising a chassis and a superstructure with a lifting member capable of raising a load and placing it at a distance from the vehicle, characterised by the provision of a strain gauge mechanism connected between the chassis and a rear axle of the vehicle to detect changes in the turning moment applied to the said axle by the weight of the superstructure and the load, the strain gauge mechanism comprising a pin with strain gauges, as hereinbefore defined, mounted thereon, the pin being mounted in the chassis and a bearing for the pin being provided on a bearing carrying member mounted on the rear axle of the vehicle so that when in use a cantilevered strain is put on the pin and further characterised in that the strain gauge mechanism is electrically connected to audible and/or visual alarm means so that electrical signals from the strain gauges give warning when the turning moment about the said rear axle is such as to render the vehicle unstable.

9. A load carrying vehicle according to any of claims 1 - 7 wherein the mechanism operable by

the strain gauge is adapted to give an audible and/or visual alarm.

10. A load handling vehicle substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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4 SHEETS

COMPLETE SPECIFICATION

SHEET 1

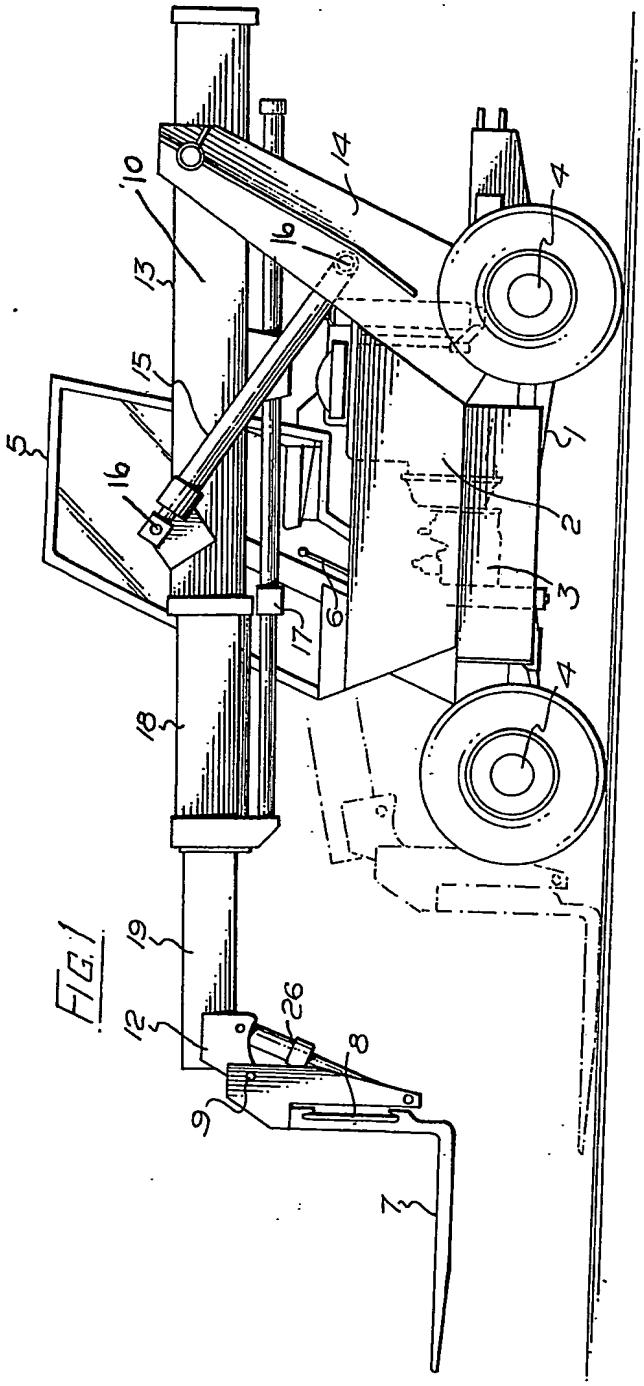

FIG.1

1 528 741 COMPLETE SPECIFICATION
4 SHEETS
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SHEET 2

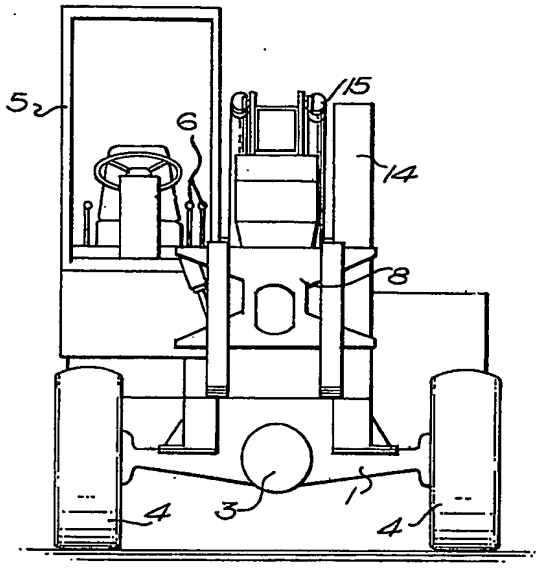

FIG. 2

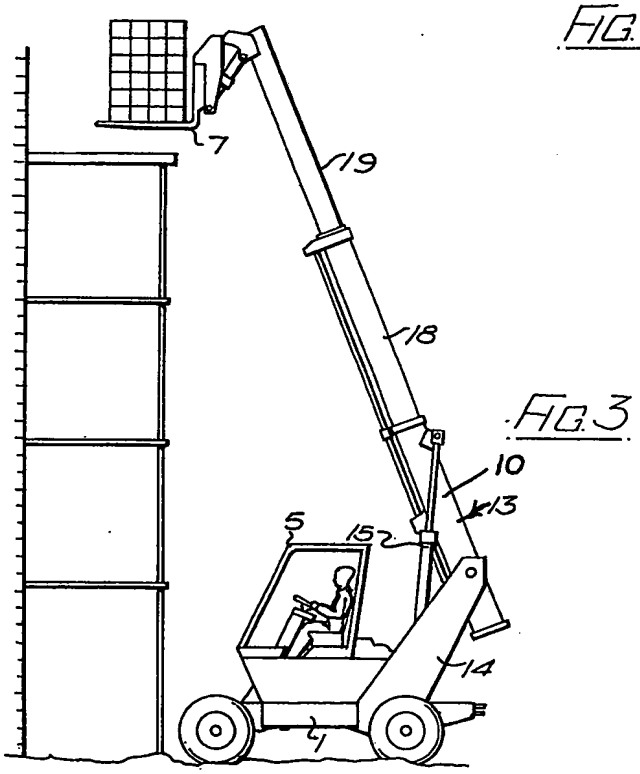

FIG. 3

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4 SHEETS

COMPLETE SPECIFICATION

FIG.4

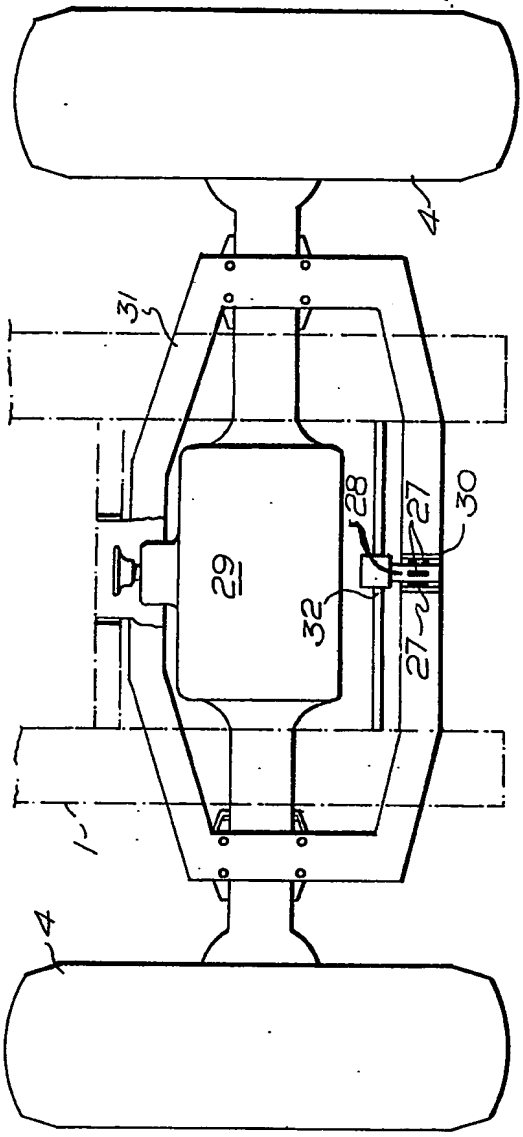
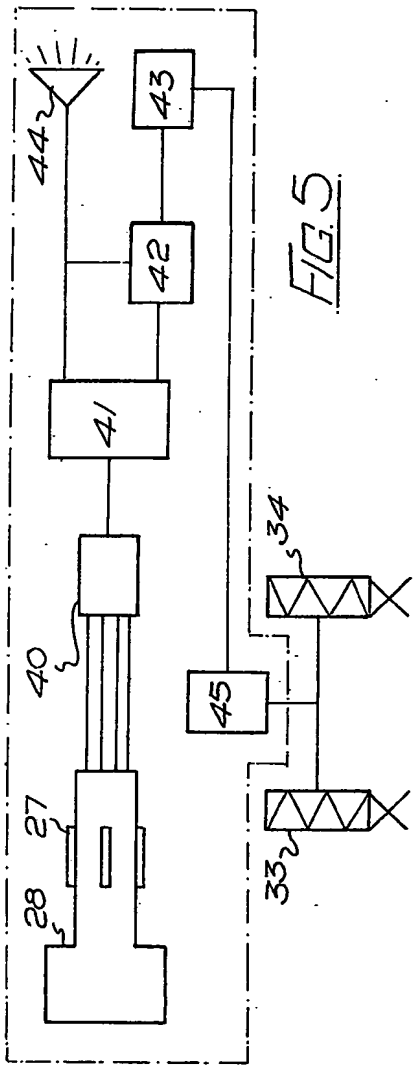


FIG.5



1 528 741
4 SHEETS

COMPLETE SPECIFICATION

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SHEET 4

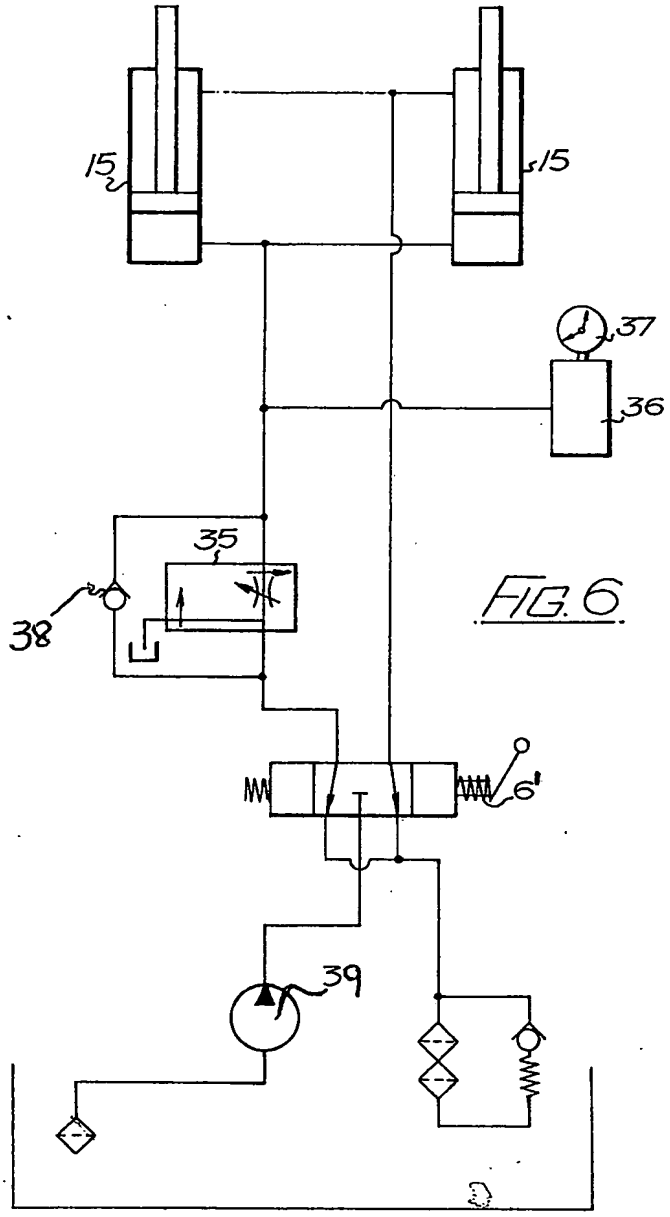

FIG. 6